(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 February 2001 (08.02.2001)

PCT

(10) International Publication Number
WO 01/09445 A2

(51) International Patent Classification[7]: E04B

(21) International Application Number: PCT/US00/18427

(22) International Filing Date: 5 July 2000 (05.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/354,749 29 July 1999 (29.07.1999) US

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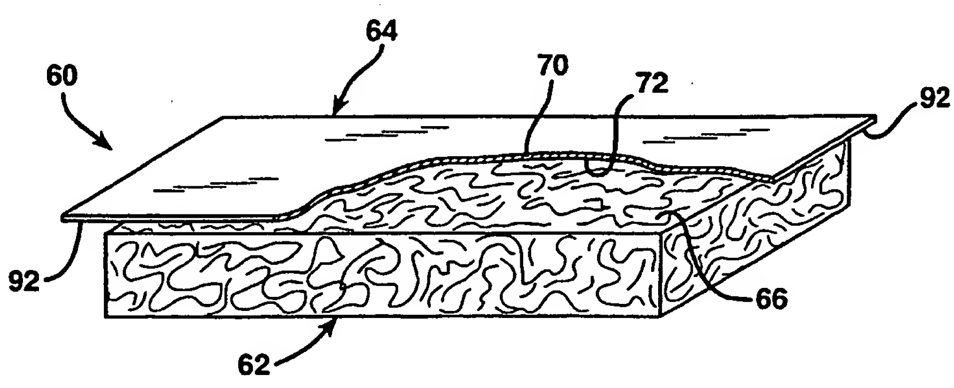
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,

[Continued on next page]

(54) Title: TECHNOLOGY FOR ATTACHING FACING SYSTEM TO INSULATION PRODUCT



(57) Abstract: An insulation product (60) includes an elongated batt (62) of fibrous insulation material, and a facing (64) adhered to a major surface of the batt. The facing is a coextruded polymer film of barrier (70) and bonding (72) (and preferably carrier) layers, with the bonding layer having a softening point lower than the softening point of the barrier layer. The bonding layer can include one or more of ethylene N-butyl acrylate, ethylene methyl acrylate, low density polyethylene and ethylene ethyl acrylate. When the facing has been heated to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer, the facing is adhered to the batt by the attachment of the bonding layer to the fibers in the batt due to the softening of the bonding layer. The heating can be either conduction heating or ultrasonic heating. For ultrasonic heating, the bonding layer is resonant at a different ultrasonic frequency than the barrier layer. Also disclosed is a technology for ultrasonically brazing two pieces of plastic together. A plastic solder layer (1106), for example, a coextruded polymer, is arranged between two plastic or composite pieces (1102, 1104) and is ultrasonically energized to weld the plastic solder layer to the first and second pieces. The ultrasonic brazing technique can join pieces of dissimilar plastic.

WO 01/09445 A2

IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *Without international search report and to be republished upon receipt of that report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TECHNOLOGY FOR ATTACHING FACING SYSTEM TO INSULATION PRODUCT

TECHNICAL FIELD AND INDUSTRIAL APPLICABILITY OF THE INVENTION

This invention relates to fibrous insulation products, and in particular those insulation products of the type suitable for insulating buildings. More specifically, this invention pertains to insulation products having a facing system for providing a vapor barrier and/or for assisting in handling the insulation products. The invention also relates to technology for attaching the facing system to insulation products. The invention also more generally relates to technology for joining plastic pieces, and more particularly for ultrasonically brazing two plastic pieces together.

BACKGROUND OF THE INVENTION

Fibrous insulation is typically formed by fiberizing molten material and depositing the fibers on a collecting conveyor. Typically the fibers for insulation products are mineral fibers, such as glass fibers, although some insulation products are made of organic fibers, such as polypropylene and polyester. Most fibrous insulation products contain a binder material to bond the fibers together where they contact each other, forming a lattice or network. The binder gives the insulation product resiliency for recovery after packaging, and provides stiffness and handleability so that the product can be handled and applied as needed in the insulation cavities of buildings. During manufacturing the insulation is cut into lengths to form individual insulation products, and the insulation products are packaged for shipping to customer locations.

One typical insulation product is an insulation batt, usually about 8 feet (2.44 meter) long, and generally suitable for use as wall insulation in residential dwellings, or as insulation in the attic and floor insulation cavities in buildings. The width of insulation batts designed for wall cavities is set to typical insulation cavity widths, such as about 14½ inches (36.83 centimeters (cm)) or 22½ inches (57.15 cm) for stud spacings of 16 and 24 inches (40.64 and 60.96 cm), respectively. Some insulation products have a facing on one of the major surfaces. In many cases the facing acts as a vapor barrier, and in some insulation products, such as binderless products, the facing gives the product integrity for handleability. Faced insulation products are installed

with the facing placed flat on the edge of the insulation cavity, typically the interior side or edge of the insulation cavity.

Insulation products where the facing is a vapor barrier are commonly used to insulate wall, floor or ceiling cavities that separate a warm interior space from a cold exterior space. The vapor barrier is usually placed to prevent moisture-laden air from the warm interior of the dwelling from entering the insulation. Otherwise, the water vapor in the warm interior air would enter the insulation material and then cool and condense within the insulation. This would result in a damp insulation product, which is incapable of performing at its designed efficiency. In warm climates it is sometimes preferable to install the vapor barrier on the exterior side of the insulation cavity to reduce the amount of vapor entering the building during the air conditioning season. The stiffness of typical asphalt-kraft-faced insulation enhances the difficulty of such installations.

There are some insulation product requirements that call for insulation that is not vapor impermeable, but rather allows water vapor to pass through. For example, retrofit insulation products designed for adding additional insulation material on top of existing attic insulation should not have a vapor barrier. Also, insulation for wall cavities having a separate full wall vapor barrier, such as a 4.0 mil polyethylene film on the interior or warm side of the wall, do not require a vapor barrier on the insulation product itself.

Encapsulation of fibrous glass batts for handling purposes is known. The Schelhorn patent (U.S. Patent No. 5,277,955 to Schelhorn et al.) discloses an encapsulated batt with an encapsulation material adhered with an adhesive that can be applied in longitudinal stripes, or in patterns such as dots, or in an adhesive matrix. The Schelhorn et al. patent also discloses that an alternative method of attachment is for the adhesive layer to be an integral part of the encapsulation film, which, when softened, bonds to the fibers in the batt.

The Syme patent (U.S. Patent No. 5,733,624 to Syme et al.) discloses a mineral fiber batt impregnated with a coextruded polymer layering system, and the Romes patent (U.S. Patent No. 5,746,854 to Romes et al.) discloses a method for impregnating a mineral fiber batt with a coextruded film. Both of these patents disclose attaching the coextruded film to the batt by heating at least the coextruded film if not also the batt. The heat energy is primarily transferred by conduction to the film as the film passes

against a heated cylinder. Optional radiant infrared (IR) heaters are also disclosed as a supplemental source of heat energy.

Attaching the coextruded film in this manner has some disadvantages. Heating cannot be abruptly terminated or quickly varied. The heated cylinder of the Syme patent and the Romes patent is a large reservoir of temperature that cannot change its temperature quickly. In addition, target areas to be heated cannot be energized with great precision. Because of the need to come in close proximity to the hot surface of the heated cylinder, areas near the targeted areas are also inadvertently heated, creating a significant penumbra of unwanted temperature elevation.

Vapor barriers for insulation products are typically created with a layer of asphalt in conjunction with a kraft paper or foil facing material. The asphalt layer is applied in molten form and it is pressed against the fibrous insulation material before hardening to bond the kraft facing material to the insulation material. This asphalt and kraft paper system has the advantage of being relatively inexpensive. However, this facing system lacks flexibility because the asphalt/kraft layer is stiff, and working with the stiff asphalt/kraft facing slows down the installation of the insulation products. Also, cutting the facing without tearing the kraft paper is difficult in cool ambient temperatures because the asphalt can be brittle. Further, and the asphalt material is sticky in hot ambient temperatures, resulting in a gumming up of the cutting tool.

Even though the batts are manufactured to fit typical insulation cavities, many of the insulation cavities in buildings are of nonstandard dimensions. Window frames, door jambs, vent pipes, air ducts and electrical conduit are some of the typical obstructions that change the shape of the insulation cavity. During the process of installing the batts a significant portion of the batts must be cut to fit these non standard insulation cavities. In some dwellings up to 50 percent of the insulation cavities are nonstandard. Therefore, an important attribute of a faced building insulation product is the ease with which the facing can be cut and the ability of the facing to be placed flat on the edge of the insulation cavity after the facing has been cut. If the facing is not flat on the edge of the insulation cavity, the vapor barrier will be only partially effective. Further, insulation customers desire a smooth facing that is relatively flat on the edge of the insulation cavity.

In view of the above problems with currently available insulation products, it would be advantageous if there could be developed a faced insulation product (and

technology for the attachment thereof) having a facing material that can be easily cut to fit into nonstandard insulation cavities, and having a facing material that is flexible enough that it can accommodate faster installation of the cut insulation product into nonstandard insulation cavities with the facing in a flat condition at the edge of the insulation cavity.

SUMMARY OF THE INVENTION

The invention is directed, in part, to an insulation product comprising an elongated batt of fibrous insulation material, and a facing adhered to a major surface of the batt, wherein the facing is a coextruded polymer film of barrier and bonding layers, with the bonding layer having a softening point lower than the softening point of the barrier layer, where the bonding layer can include one or more of ethylene N-butyl acrylate, ethylene methyl acrylate ethylene ethyl acrylate, low density polyethylene (LDPE) and ethylene vinyl acetate, and wherein the facing has been heated to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer, whereby the facing is adhered to the batt by the attachment of the bonding layer to the fibers in the batt due to the softening of the bonding layer.

The invention is also, in part, directed to an insulation product comprising an elongated batt of fibrous insulation material, and a facing adhered to a major surface of the batt, wherein the facing is a coextruded polymer film of barrier, carrier and bonding layers, with the bonding layer having a softening point lower than the softening point of the barrier layer, and with the carrier layer being positioned between the barrier and bonding layers, wherein the facing has been heated to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer, whereby the facing is adhered to the batt by the attachment of the bonding layer to the fibers in the batt due to the softening of the bonding layer.

The invention is also, in part, directed to a method of making an insulation product comprising positioning a facing in contact with a major face of an elongated batt of fibrous insulation material, wherein the facing is a coextruded polymer film of barrier and bonding layers, with the bonding layer including one or more of ethylene N-butyl acrylate, ethylene methyl acrylate, LDPE and ethylene ethyl acrylate, and with the bonding layer having a softening point lower than the softening point of the barrier layer, and heating the facing to a temperature above the softening point of the bonding

layer, but below the softening point (or bond initiation temperature, BIT) of the barrier layer, while maintaining the facing in contact with the batt to soften the bonding layer to an extent sufficient attach the bonding layer to the fibers in the batt and thereby adhere the facing to the batt.

The invention is also, in part, directed to a method for installing an insulation product and a correspondingly insulated studded wall. The method comprises providing an insulation product including an elongated batt of fibrous insulation material and a facing adhered to a major surface of the batt. The facing is a coextruded polymer film of barrier and bonding layers, with the bonding layer having a softening point lower than the softening point of the barrier layer. The facing has been heated to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer, whereby the facing is adhered to the batt by the attachment of the bonding layer to the fibers in the batt due to the softening of the bonding layer. The facing has no flanges. The method further comprises installing the insulation product in an insulation cavity by pressing the insulation product into place between opposed structural members. Alternatively, the copolymer facing can be installed as a separate continuous sheet across the cavities in the studded wall.

The invention is also, in part, a recognition that ultrasonic bonding of films can be achieved without the high pressures and hard opposing surface (relative to the ultrasonic radiation source) of known ultrasonic welding technology.

The invention is also, in part, directed to a method (and an apparatus to implement the method) for attaching a facing to a mineral fiber batt, the method comprising: providing the batt; providing the facing; positioning the facing to be in contact with the batt; and ultrasonically energizing the facing sufficient to soften a portion of the facing onto fibers of the batt. Preferably, the facing is a coextruded polymer film, the first layer of which is a bonding layer that is resonant at a first frequency of ultrasonic radiation. The second layer is preferably not resonant at the first frequency. More preferably, the second layer is a carrier layer.

The invention is also, in part, directed to an apparatus for attaching at least two facings to a mineral fiber batt, the apparatus comprising: a first facing source; a first roller arranged to place a first facing from the first facing source into contact with a first side of the batt; a first heating source operable to heat a region through which passes the first facing while in contact with the batt, the heating by the first heating source being

sufficient to soften a portion of the first facing onto fibers of the batt; a second facing source; a second roller arranged to place a second facing from the second facing source into contact with a second side of the batt; and a second heating source operable to heat a region through which passes the second facing while in contact with the batt, the heating by the second heating source being sufficient to soften a portion of the second facing onto fibers of the batt.

The invention is also, in part, directed to a technology for ultrasonically brazing two pieces of plastic together and to a correspondingly conjoined plastic assembly. For example, the technology can take the form of a method comprising: providing a first piece of plastic and a second piece of plastic; arranging a plastic solder layer on a surface of the first piece that is to be joined to the second piece of plastic; positioning the second piece to contact the plastic solder layer; and ultrasonically energizing the facing sufficient to weld a first portion of the plastic solder layer to the first piece and to weld a second portion of the plastic solder layer to the second piece. Preferably, the plastic solder layer is a coextruded polymer.

The foregoing and other objectives of the present invention will become more apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus do not limit the present invention.

Fig. 1 is a schematic view in perspective of typical nonstandard wall insulation cavities.

Fig. 2 is a schematic perspective view of the wall cavities of Fig. 1, partially cut away and insulated with typical prior art insulation products.

Fig. 3 is a schematic perspective view of a faced insulation product according to the present invention, with a portion cut away.

Fig. 4 is a schematic perspective view of the insulation product of Fig. 3, partially cut away and installed into the wall cavity of Fig. 1.

Fig. 5 is a schematic perspective view, similar to Fig. 3, of another embodiment of the insulation product according to the present invention, having no side edge extensions or flanges.

Fig. 6 is a schematic perspective view of another embodiment of the insulation product according to the present invention, with a portion cut away, and having encapsulation material on the rear and sides of the insulation product.

Fig. 7 is a schematic perspective view of a first apparatus for manufacturing the insulation products according to the invention.

Fig. 8 is a schematic perspective view illustrating a faced insulation product of the invention, having been slit longitudinally to provide a partial batt suitable for insulating the nonstandard insulation cavity of Fig. 1.

Fig. 9 is a schematic cross-sectional view in elevation illustrating the various layers of a multilayer facing film of the invention.

Fig. 10 is a schematic perspective view of a second apparatus for manufacturing the insulation products of the invention.

Fig. 11 is a cross-sectional view of a first ultrasonic brazing arrangement according to the invention.

Fig. 12 is a cross-sectional view of a second ultrasonic brazing arrangement according to the invention.

Fig. 13 is a cross-sectional view of an alternative thermoplastic solder layer according to the invention.

Fig. 14 is a schematic perspective view of a third apparatus for manufacturing insulation products according to the invention.

The appended drawings are not necessarily drawn to a consistent scale.

DETAILED DESCRIPTION AND PREFERRED EMBODIMENTS OF THE INVENTION

While the description and drawings disclose insulation products of fiberglass insulation, it is to be understood that the insulation material can be any compressible fibrous insulation material, such as rock wool, polypropylene or polyester.

As shown in Fig. 1, a typical wall structure, indicated generally at 10, includes a bottom plate 12 on which rests a plurality of studs 14. The bottom plate, studs and a top plate, not shown, define the four sides of insulation wall cavities 16, 18 and 20. The front and the back of the wall cavity are typically made of drywall on the interior side and foam sheathing on the exterior, both not shown. Wall cavity 16 can be considered to be a non-standard wall cavity since it has a width much narrower than that of a typical wall cavity. Insulating wall cavity 16 will require cutting the insulation product to a narrower width. Insulation cavity 18 is also difficult to insulate since there is a vent pipe 22 running vertically within the cavity, making cavity 18 a nonstandard cavity. Insulating cavity 18 will usually require cutting an insulation batt longitudinally into two narrower insulation pieces, not shown in Fig. 1. For insulation purposes, insulation cavity 18 can be considered to comprise two partial cavities, indicated at 24 and 26, each of which must be insulated. Insulation cavity 20 is also a nonstandard cavity since the insulation material must be positioned around an electrical outlet box 28 and conduit 30. Installation of the insulation material around these obstructions requires cutting the batt to fit it around the obstruction. Other typical obstructions include door jambs, window frames, air ducts, and water pipes, all not shown.

As shown in Fig. 2, a typical flanged prior art insulation product has been cut to a narrow partial insulation product 32 and installed in insulation cavity 16. Also another prior art insulation product 34 has been installed in nonstandard wall cavity 18, and another similar prior art insulation product 36 has been installed in non standard wall cavity 20. The rear of the insulation cavities 16, 18 and 20 is defined by exterior sheathing 38. It can be seen that in order to install the insulation product 34 into the nonstandard insulation cavity 18, the insulation product was split longitudinally into two partial batts 40 and 42. Further, the facing material 44, which is a kraft paper bonded to the fibrous insulation material by asphalt, has been cut to form the facing for the two partial batts 40 and 42.

The facing material of insulation product 34 is attached to the studs 14 by staples 46. Although the stapling of the flanges of the insulation product 32 can be to the ends of the studs, it is preferred that the flanges be side stapled to the sides of the studs. This procedure leaves the ends or exposed edges of the studs smooth for a potentially better application of the drywall. Unfortunately the side or inset stapling of the flanges requires the asphalt/kraft facing to be bent, creating a valley-shaped

depression or crease 48 running the length of the insulation product. This crease 48 is undesirable because the insulation material is prevented from flat, smooth contact with the front edge of the insulation cavity, and additionally the insulation material can be overcompressed, thereby lowering the insulation value of the insulation product. Also, the stiff asphalt/kraft facing 44 cannot always be stapled flat against the side of the stud 14, leaving fishmouth or openings 50 between the facing and the sides of the studs.

The insulation of the two partial cavities also presents a problem. It can be seen that the portions of the facing material on the two partial batts 40 and 42 are slightly separated, forming a gap 52 through which water vapor can travel into the insulation material of the batt. The gap 52 is typically caused because cutting the batt and facing material is difficult when the facing material is an asphalt/kraft paper system, as shown in Fig. 2. The opening 50 and the gap 52 are undesirable aspects of the insulation job illustrated in Fig. 2.

The installation of prior art insulation product 36 into insulation cavity 20 involved cutting out a portion of the fibrous insulation material around the electrical outlet box 28. If the insulation were installed without cutting out for the electrical outlet box, the insulation would be over compressed, and might even affect the drywall. Cutting the insulation to accommodate the outlet box required a portion of the flange to be removed. With a conventional asphalt/kraft facing it is difficult to obtain a good seal if a portion of a flange is missing. The difficulty in obtaining a good seal because of the cutout for the outlet box and other obstructions, and because of other imperfections in the structure, results in the openings 50 between the facing material 44 and the stud walls 14. Because of the stiffness of the asphalt/kraft facing combination, openings similar to openings 50 can occur even with standard insulation cavities having no obstructions in situations where the studs are uneven or out of alignment.

As shown in Fig. 3, the insulation product of the invention, indicated generally at 60, is comprised of an elongated batt 62 of fibrous insulation material, and a facing 64 adhered to a major surface, front surface 66 of the batt 62. The fibrous insulation material is preferably fibrous glass having a density within the range of from about 0.3 to about 15.0 pounds per cubic foot (pcf) (about 4.80 to about 240.2 kilograms per cubic meter (kg/m^3), although other densities can be used. Also, other fibers, such as mineral fibers of rock, slag or basalt, can be used as well as organic fibers such as the polymer fibers polypropylene, polyester and polysulfide, as well as other organic fibers.

The fibers may be bonded together with a binder material, such as a urea phenol-formaldehyde commonly used with fiberglass insulation, or the glass fibers can be binderless. Binderless glass fibers will be capable of much greater movement within the insulation pack structure than fibers in a pack structure with binder. As used in the present specification and claims, the term "binderless" means the absence of binder materials or the presence of only small amounts of such binder materials, amounting to no more than one percent by weight of the insulation product. Addition of suppressants, for example oils, for dust control or other purposes is not considered a binder. An example of an encapsulated binderless product is disclosed in the U.S. Patent No. 5,277,955 to Schelhorn et al., as mentioned above.

The facing 64 is a dual layer facing comprising a coextruded polymer film of a barrier layer 70 and a bonding layer 72. The purpose of the barrier layer 70 is to provide a tough but flexible outer surface for the insulation product 60. The barrier layer 70 is a vapor barrier, although in other embodiments of the insulation, where the insulation product does not need to provide vapor protection, the barrier layer can be vapor porous. Although the preferred form of the facing 64 is a coextruded polymer film, it is to be understood that in other forms of the invention the facing is made of a dual layer film that is not coextruded, but rather formed in another manner, such as by as adhesive, heat lamination or chemical bonding.

The softening temperatures of the barrier layer 70 and bonding layer 72 are different by about 100°F (38°C) with the bonding layer having a softening point lower than the softening point of the barrier layer. During the manufacturing process the facing 64 is adhered to the batt 62 by heating the facing to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer. The facing is adhered to the batt 62 by the attachment of the bonding layer 72 to the fibers in the batt due to the softening of the bonding layer.

A preferred material for the barrier layer is a high density polyethylene (HDPE) film having a softening point within the range of from about 250°F (121°C) to about 280°F (138°C), and most preferably about 275°F (135°C). High molecular weight HDPE can also be used, but a greater cost. Another material suitable for the barrier layer is a polypropylene film having a softening point within the range of from about

330°F (166°C) to about 390°F (199°C). Other polymer films, such as polypropylene, polyester and polystyrene could also be used.

A preferred material for the bonding layer is a film of one or more of ethylene N-butyl acrylate (E*t*-BA), ethylene methyl acrylate (EMA), ethylene ethyl acrylate (EEA), low density polyethylene (LDPE) and ethylene vinyl acetate (EVA). These materials are available from Newtech Plastics, Inc., Covington, Ohio, and they can be used alone, in combination with each other, or in combination with other materials, such as a low melt polyethylene material. The softening points of these materials are within the range of from about 100°F (38°C) to about 200°F (93°C), and most preferably within the range of from about 120°F (49°C) to about 180°F (82°C). Preferably these ethylene acrylate materials are synthesized using a metallocene catalyst to lower the softening point. Another material potentially useful for the low melt bonding layer is a low melt or low density polyethylene, preferably synthesized using a metallocene catalyst to lower the softening point.

The difference in softening temperatures for the barrier layer and the bonding layer is preferably within the range of from about 50°F (10°C) to about 225°F (107°C), and for an HDPE/ethylene acrylate system (that is, ethylene N-butyl acrylate, ethylene methyl acrylate and ethylene ethyl acrylate), the temperature difference is about 140°F (60°C). One of the great advantages of the HDPE/ethylene acrylate facing system of the invention is that the facing and insulation product can be cut easily over a broad temperature range. The bonding layer 72 is readily cuttable at even such warm temperatures as about 110°F (43°C), and will not leave a gummy residue on the cutting tool. The facing does not soften at temperatures less than about 110°F (43°C), and is not brittle at temperatures greater than about 30°F (-1°C). Another advantage of the faced insulation product 60 of the invention is that the facing 64 is more flexible than a conventional asphalt/kraft paper facing. As measured by ASTM test D-1388 the flexural rigidity of the facing of the invention is preferably less than 500 gram per centimeter (gm cm), whereas the flexural rigidity of standard asphalt/Kraft facing is greater than about 2000 gm cm. Further, the elastic (tangent) modulus of the facing 64 of the invention, as measured by ASTM D-882, is within the range of from about 25,000 to about 200,000 pounds per square inch (psi) (about .172 to about 1.38 GPa).

Typically, the elastic modulus of the facing of the invention is about 100,000 psi (.689 GPa).

In its most preferred form the facing is a multilayer film 78, as shown in Fig. 9, comprising a barrier layer 80, a bonding layer 82 and a carrier layer 84. The barrier layer 80 and bonding layer 82 can be similar to the HDPE and ethylene acrylate (that is, ethylene N-butyl acrylate, ethylene methyl acrylate and ethylene ethyl acrylate) layers 70 and 72, respectively. The carrier layer can be a linear low density polyethylene (LLDPE) with a softening point of about 230°F (110°C) or a high density polyethylene (HDPE), and the carrier layer can be reinforced by any suitable material. Using a carrier layer is particularly advantageous where the difference in softening temperatures between the barrier layer and the bonding layer is great. The carrier layer provides an insulative barrier between the barrier layer and the bonding layer during the coextrusion of the polymer film sufficient to improve the permissible difference in softening temperatures between the barrier layer and the bonding layer, preferably by at least 30°F (-1°C). Another advantage of using a carrier layer is that it allows separation of the function of the vapor barrier quality of the barrier layer and the outside surface of the facing as follows: the carrier layer (that is, the middle layer of the three layers) can be configured to be the actual vapor barrier layer, and the outside layer can be a high friction surface that is not necessarily a vapor barrier, but is a surface designed for good printability. High density polyethylene may be too slippery for good printing.

In another embodiment, not shown, the multilayer facing film includes four individual layers, two HDPE layers, a carrier layer, and a bonding layer. In yet other embodiments, the number of layers can be up to eleven or greater.

When exposed to fire, the facing on a fibrous pack insulation product preferably will shrink and pull away from the fibrous pack. By pulling away, the facing retards the spread of the flames. Preferably, the rate at which the facing shrinks and pulls away, that is, the debonding rate, should be small below about 150°F (66°C), and should be large above about 180°F (82°C), especially in the range of about 170°F-180°F (77°C-82°C). The embodiments of the invention that emphasize shrinking and pulling away of the facing preferably form the bonding layer of EMA, EEA, E*t*-BA, Surlyn or low-melt-temperature polyethylene. Where Surlyn® (a type of ionic

copolymer marketed by DuPont) is used as the bonding layer material, a flame spread (FS) has been achieved, which is comparable to conventional foil-faced products.

The shrinkage of the facing does not occur instantly, so another embodiment of the invention adds a fire retardant layer to the multilayer facing. The fire retardant layer retards the spread of flames during the time it takes for the facing to unbond and then shrink. Where such a layer includes, for example, antimony oxide and a halogen, a low FS rating has been achieved. A phosphate-based fire retardant can also be used. A multilayer facing that includes a Surlyn bonding layer and a fire retardant layer should achieve an even lower FS rating.

Another embodiment of the invention selects the bonding layer so that flanges formed from it will bond together when overlapped. When a flanged insulation product is installed in a studded wall cavity, the flanges are typically stapled to the studs. A stud located between neighboring cavities will typically have the flange from the insulation in one cavity stapled over the top of a flange from the insulation in the other cavity. The coextruded film facing according to the invention can be formulated so that the bonding layers, over time due to the pressure of the overlying gypsum wallboard, will bond together when overlapped as described above.

In some northern areas, the building code requires that a separate continuous vapor barrier of thick polyethylene film be stapled and bonded with an adhesive over the installed (typically unfaced) insulation products.

According to the invention, the separate continuous vapor barrier is preferably made of a copolymer film as discussed herein rather than thick polyethylene film.

Alternatively, the insulation products incorporating the coextruded film facing according to the invention eliminate the need for such a discrete barrier because the individual facings bond together, especially if the overlapped flanges are heated, for example, with a heat gun or a heated roll. As a further alternative, the bonding layer can be formulated to be slightly tacky when cooled so as to enhance the attachment of the overlapped flanges.

In another embodiment, an uppermost layer of the coextruded film facing is coated with metal and another layer is, or preferably several layers (to prevent pinholes in different layers from aligning) are, chosen to function as a vapor barrier layer. In appearance, this product will appear like a conventional foil-scrim-kraft (FSK) facing. This similar appearance of this embodiment will ease its entry into the market for FSK

faced-insulation products. Though similar in appearance, such a product has superior vapor impermeability and mechanical strength relative to an FSK faced-product.

The facing 64 for the insulation product 60, and the facing 78 for the multilayer product both have an overall thickness, before the bonding step, within the range of from about 0.4 to about 4 mils (about 10 to about 100 microns), and preferably within the range of from about .5 to about 1.5 mils (about 12.5 to about 37.5 microns). The two layers of the two-layer facing 64 preferably have equal thicknesses. For the multiple facing 78, preferably each of its three layers is roughly one-third of the thickness of the facing. Individual thickness could be different - example .25, .25 and .50 inch (.635, .635 and 1.27 cm).

As shown in Fig. 4, the insulation product 60 of the invention is applied into nonstandard insulation cavities 16, 18 and 20. In the insulation cavity 18 the insulation product has been divided or cut into partial batts in order to fit around the vent pipe 22. Because of the flexibility and cutability of the facing 64, however, the only evidence of the fact that the insulation product 60 is divided into two partial batts is the seam 88 in the facing 64. This seam can be of minimal width, with practically no gap, as shown. Further, in contrast to the jagged gap 48 in the prior art cut asphalt/kraft facing 44 illustrated in Fig. 2, the seam 88 is relatively straight. In a similar manner, the cutting of the insulation product 60 to accommodate the electrical box 28 can be accomplished without a seam. The insulation of cavities 16, 18 and 20 with the insulation product 60, having the flexible facing 64, lends itself to a smooth appearance for the insulation product, and the friction fit of the insulation product 60 enables installation without the need for staples or other fasteners. Optionally, the seams 88 can be covered with tape to provide an absolute vapor barrier, but this should not usually be necessary with the facing of the invention.

As shown in Figs. 3 and 4, the facing 64 can be provided with extension flaps 92 that can be tucked between the insulation product 60 and the studs 14 to provide a better vapor seal at the side edges of the insulation product. The conventional asphalt-kraft facing is too stiff to permit such tucking, as a practical matter. The extension flaps 92 could be used for stapling purposes, and therefore should also be considered stapling flanges. Preferably, the extension flaps extend about .50 to 1 inch (1.27 to 2.54 cm) beyond the side edges of the batt. When the facing is a coextruded dual or tri-layer film having a low softening point bonding layer on side facing the fibrous insulation batt,

the difference in softening points and coefficients of thermal expansion between the two layers causes a curling of the extension flap toward the insulation material. This curling helps provide a good seal when the extension flap is tucked between the facing and the stud.

A particular advantage of the insulation product and method of the invention is the reduction in installation time for the insulation. The elimination of the stapling of flanges for the product of the invention significantly reduces the installation time, with the installation time of the product of the invention being at least 10 percent faster, and possibly up to 50 percent faster than standard asphalt/kraft faced insulation. The time savings come from elimination of the stapling operation and eliminating the use of the stiff kraft paper that is hard to handle and install in the wall.

As shown in Fig. 5, another embodiment of the invention is similar in all respects to the insulation product illustrated in Fig. 3 except that there are no extension flaps.

In an alternate embodiment of the invention illustrated in Fig. 6, an insulation product 94, has a facing 96, similar to the facing 64, on one major surface of the batt 98. This insulation product is provided with an encapsulation film 100 on the side edges 102 and rear major face 104 of the batt. The encapsulation film can be attached to the fibrous batt in any suitable manner, such as by an adhesive layer or strip. For example, a strip of hot melt adhesive can be applied in liquid form during manufacture of the insulation product. For example, U.S. Patent No. 5,277,955 to Schelhorn et al. discloses an encapsulated batt with an encapsulation material adhered with an adhesive that can be applied in longitudinal stripes, or in patterns such as dots, or in an adhesive matrix. Alternatively, the encapsulation film can be securely bonded to the entire surface of the side edges and the rear major surface, such as by using a multilayer coextruded film similar to the facing 64. Such a film might be, for example, a dual film of HDPE and polyethylene (PE), with a thickness within the range of at least about 0.5 to about 0.8 mils (about 12.5 to about 20 microns) if not in range of about 0.3 to about 1.5 mils (about 7.5 to about 37.5 microns). Although the embodiment of the invention shown in Fig. 6 includes encapsulation on the side edges and rear major surface of the batt 98, it is to be understood that another embodiment of the invention, not shown, provides encapsulation material on the rear surface only, with the side edges lacking the encapsulation material.

The insulation product 94 optionally can be provided with an opening 106 in the side edge of the facing 100 to expose the glass fibers in the batt 98. The glass fibers inherently have high friction component, and therefore the opening 106 provides a friction enhancing aspect of the batt to aid in the friction fit application of the insulation product 94 into insulation cavities. Another friction enhancing element is the addition of friction surface treatment, such as a semi-tacky coating, to the side edge of the facing 100.

The encapsulation material can be applied to the insulation batt by any suitable process. Apparatus suitable for directing and guiding the encapsulation material onto the glass fiber pack is disclosed in U.S. Patent No. 5,545,279 to Hall et al., the entirety of which is hereby incorporated by reference. As shown in Fig. 7, a pack 110 of glass fibers is being carried on a conveyor 112. The manufacture of the glass fiber pack 110 is well known technology, and those skilled in the art will be aware of several conventional methods for producing glass fiber packs. The glass fiber pack is preferably a light density insulation material, having a density within the range of from about 0.3 to about 1.0 pcf (about 4.8 to about 16.01 kg/m^3). The glass fiber pack can be bonded with a binder material, such as a urea phenol-formaldehyde binder, as is well known in the art. Alternatively, the glass fiber pack can be binderless.

A sheet of the facing material 64 is payed out from roll 114 and directed into contact with the glass fiber pack 110. The facing material 64 is pressed into forceful contact with the pack by the action of journaled pressing rolls 116 and 118, which compress the glass fiber pack by a ratio of up to about 25:1, and preferably about 5:1. The amount of compression needed will be a function of the density. The upper pressing roll 116 is heated so that the temperature of the facing 64 will increase to a point above the softening point of the bonding layer. The heating of the roll 116 can be accomplished in a variety of ways, such as by electrical resistance heating or by the circulation of hot oil. The combination of the softened bonding layer and the extreme pressure applied by the two pressing rolls 116 and 118 causes the bonding layer to firmly bond the barrier layer to the glass fiber pack 110. An alternative method of heating the bonding layer is with an infrared heater 120, as shown. Such a heater would have to be positioned immediately upstream of a pair of pressing rolls, not shown, similar to rolls 116 and 118, so that the softened bonding layer could be pressed into the fibrous batt and be integrally bonded to the batt. Alternatively, ultrasonic, laser and

microwave bonding can be used. The alternative of ultrasonic bonding will be discussed in more detail below relative to Fig. 10. Optionally, a cooling section, not shown, can be used to cool the softened layer after the bonding process.

As also shown in Fig. 7, the remainder of the surface of the fibrous pack 110, that is, the side edges 102 and the rear major face 104 can be encapsulated with encapsulation material or film 100 which can be supplied by encapsulation film roll 122. The film 100 can be applied using a folding shoe 124, an example of which is disclosed in the above-identified U.S. Patent No. 5,545,279 to Hall et al. As disclosed above, the encapsulation film can be bonded with small amounts of discrete adhesive bands. The adhesive can be applied in a variety of ways, such as by an adhesive nozzle 126, supplied with an appropriate adhesive from a source, not shown. In the alternative, the encapsulation film 100 can be securely bonded to the entire surface of the side edges and the rear major surface with a multilayer coextruded film similar to the facing 64, as disclosed above. Also, it is to be understood that the encapsulation material can be applied just to the rear surface, leaving the side edges unencapsulated.

As shown in Fig. 8, a faced insulation product 60 of the invention has been slit longitudinally to provide partial batts 130 and 132 suitable for insulating nonstandard insulation cavities. The insulation product 60 is faced with the facing 64 of the invention, but there is no encapsulation material. The insulation product is a bindered product, and therefore the partial batts 130 and 132 will maintain their shape and handleability even when cut. Either of the partial batts is suitable for insulating nonstandard insulation cavities, such as the partial cavity 26 shown in Fig. 1, or such as the narrow cavity 16 shown in Fig. 1.

Fig. 10 is a schematic perspective view of a second apparatus for manufacturing the insulation products of the invention. Fig. 10 is similar to Fig. 7. The following discussion will concentrate on the differences between Fig. 10 and Fig. 7. The greatest difference is that, in Fig. 10, the energy used to melt the facing material, for example, a coextruded polymer, 64 is supplied as ultrasonic energy rather than via conduction heating. This has the benefit that the energy can be applied precisely to a desired region, that is, localized, without the unavoidable heat penumbra associated with conduction heating. Ultrasonic heating is similarly more selective than infrared (IR) heating. Moreover, ultrasonic energization can be turned on and off abruptly with little

to no phase lag. In contrast, the apparatus needed to implement conduction heating cannot be cooled or heated quickly.

In Fig. 10, the heated pressing roll 116 and the complimentary pressing roll 118 have been replaced by an unheated pressing roll 116A and its complimentary unheated pressing roll 118A. Together, they form a first nip or pinch. An optional, but preferred, second pinch is provided by unheated pressing rolls 116B and 118B. The first and second nips are separated by a distance sufficient to accommodate at least a first ultrasonic radiation source 128A, located above the facing material 64. Preferably, the distance is sufficient to also accommodate a second ultrasonic radiation source 128B, located above the facing material 64. Second source 128B is preferably considered to be a redundant backup to the first source 128A so that if the first source 128A fails or must be serviced, the entire production line does not have to be incapacitated.

Alternatively, a pair of ultrasonic radiation sources 128C and 128D could be located below the fibrous pack or batt 110. The lower location of the sources 128C and 128D is less preferred than the upper location of the sources 128A and 128B because the ultrasonic radiation must travel through the fibrous pack 110 to reach the facing material 64. In addition, the effects of gravity tend to keep the sources 128A and 128B cleaner than the sources 128C and 128D. Also alternatively, the sources 128C and 128D could be replaced with rollers.

In operation, the first nip (between the rollers 116A and 118A) compresses the facing material 64 against the fibrous pack 110 by a ratio of up to 25:1, and preferably about 5:1. The compressed pack 110 and facing material 64 pass before the first ultrasonic radiation source 128A. The source 128 emits enough energy so that a portion of the facing system melts sufficiently to permit a portion of the fibrous batt 110 to be pressed into the softened facing material 64. Preferably, the facing material is energized in a cross-hatch or web pattern, according to the technology disclosed in commonly assigned and co-pending U.S. patent application serial no. 09/088, 990, filed June 2, 1998, for whom Bharat Patel, Larry J. Grant, Dallas L. Dudgeon, Matthew L. Brokaw, Weigang Qi and Russel Marsh Potter are the inventors, the entirety of which is hereby incorporated by reference. The same preference for softening the facing material 64 in the cross-hatch or web pattern is true for the embodiment of Fig. 7.

Once the facing material 64 and the fibrous batt 110 leave the first nip (between the rollers 116A and 118A), they begin to decompress. This decompression retards the pressing of the fibrous batt 110 into the softened facing material 110, that is, the decompression promotes debonding. Fortunately, the ultrasonic heating imparts the minimum energy to the facing material 64, so that it re-solidifies quickly before significant debonding can take place. The optional, but preferred, second nip (between the rollers 116B and 118B) is located closely enough to the first nip so that the deleterious effects of the decompression can be minimized before the softened facing material 64 can re-solidify. The compression of the second nip is comparable to the first nip.

Alternatives to the pinch rollers 116 A, 118A, 116B and 118B include flat pieces or caterpillar conveyer belts that are similar to the conveyors 112.

Again, in Fig. 10, the facing material 64 is preferably a coextruded polymer film, as in the embodiment of Fig. 7. The choice of the materials for the various layers depends upon the particular circumstances to which the invention will be applied. However, the bonding layer, for example, 82 of Fig. 9, should resonate at a first frequency of ultrasonic radiation to which the other layer(s) is not resonant. In addition, the melting point(s) of the other layer(s) should be selected so that the other layers are not sympathetically melted via conduction heating due to the increase in temperature of the bonding layer.

Fig. 14 is a schematic perspective view of a third apparatus for manufacturing insulation products according to the invention. Fig. 14 is similar to Fig. 10. The following discussion will concentrate on the differences between Fig. 14 and Fig. 10.

Rather than having one roll 114 of facing 64, the left-hand part 1400 of Fig. 14 has two, namely rolls 114A and 114B of facings 64A and 64B, for example, coextruded polymer. The first facing 64A is attached ultrasonically to the top of the fibrous pack 110. The second facing 64B is ultrasonically attached to the bottom of the fibrous pack 110. In Fig. 14, the ultrasonic radiation source 128C is the primary energy source for heating the facing 64B. The ultrasonic radiation source 128D is preferably a redundant backup to the source 128C in the same relationship as source 128B relative to source 128A.

If it is desired to have a doubly-faced product as the final product, one might choose to make coatings 64A and 64B different. In this case, the coating 64A might be

formulated to be a vapor barrier while the coating 64B might be formulated to be permeable to water vapor. The sides could also be encapsulated.

The double faces of Fig. 14 could alternatively be attached using the conductive heating system of Fig. 7. In that case, the ultrasonic sources 128A, 128B, 128C and 128D would not be present and the rollers 116A and 116B would be heated.

As noted above, the invention also relates more generally to technology for joining thermoplastic pieces or thermo set pieces, that is, plastic pieces, and more particularly for ultrasonically brazing two plastic pieces together. As contrasted with ultrasonic welding, ultrasonic brazing is intended to connote ultrasonic welding using a plastic solder layer to achieve a hot melt adhesive connection.

In Fig. 11, a first plastic piece 1102 is arranged next to a second plastic piece 1104 to form a conjoined plastic assembly. A plastic solder layer 1106 is inserted between the two pieces 1102 and 1104. An ultrasonic radiation source 1108 is located over the first piece 1102 so that the first piece 1102 is used as a conduit to convey the ultrasonic energy to the plastic solder layer 1106 to soften (1) at least a first portion of the plastic solder layer 1106 so that it adheres to the first piece 1102 and (2) a second portion of the plastic solder layer 1106 so that it adheres to the second piece 1104. The pieces 1102 and 1104 preferably do not soften due to the ultrasonic radiation from the source 1108. In a basic version of this technology, the first piece 1102, the plastic solder layer 1106 and the second piece 1104 are formed of the same material. The plastic solder layer is preferably 0.5-1.0 mm thick, and more preferably 0.5 mm thick.

However, this ultrasonic brazing technology can also join plastic pieces formed of different materials. In Fig. 12, the first piece 1102 is the same as in Fig. 11, but the second plastic piece is indicated as item 1200 to emphasize that it is formed of a different material than first piece 1102. The plastic solder layer 1202 is preferably a coextruded polymer that includes at least a first layer 1204 (formed of the same material as the first piece 1102) and a second layer 1206 (formed of the same material as the second piece 1200).

The second material, corresponding to the second piece 1200 and the second layer 1206, is likely to be resonant at a different frequency than the first material, which corresponds to the first piece 1102 and the first layer 1204. A second source 1208 of ultrasonic radiation is depicted underneath the second piece 1104 to provide the frequency of ultrasonic radiation at which the second material is resonant.

In addition to thermoplastic material, the ultrasonic brazing according to the invention can be applied to composite material, that is, a thermoplastic embedded with fibers.

Fig. 13 depicts an alternative plastic solder layer 1300. The plastic solder layer 1300 has a carrier layer 1302 formed between the first and second layers 1204 and 1206. The carrier layer 1302 is similar to the carrier layers of the embodiment discussed above. In addition, the carrier layer 1302 is selected to not be resonant at the ultrasonic resonant frequencies of the first and second layers 1204 and 1206.

The two pieces of plastic in Fig 3. 11 or 12 could, for example, correspond to the edges of an envelope or the wrapping on a package.

The ultrasonic brazing according to the invention does not require the textured/patterned hard opposing surface (relative to the ultrasonic radiation source) of known ultrasonic welding technology. The hard opposing surface of the known ultrasonic welding technology can wear out, that is, the texture/pattern on the surface can wear away. The ultrasonic brazing according to the invention can be adapted to use such a worn out mold, that is, to extend the life of the mold.

The principle and mode of operation of this invention have been described in its preferred embodiments. However, it should be noted that this invention may be practiced otherwise than as specifically illustrated and described without departing from its scope.

WHAT IS CLAIMED IS:

1. An insulation product (60) comprising an elongated batt (62) of fibrous insulation material, and a facing (64) adhered to a major surface of the batt, wherein the facing is a coextruded polymer film having a bonding layer (72), and at least one barrier layer (70) with the bonding layer having a softening point lower than the softening point of the barrier layer, with the bonding layer being one or more materials of the group consisting of ethylene N-butyl acrylate, ethylene methyl acrylate, ethylene ethyl acrylate and ethylene vinyl acetate, and wherein the facing has been heated to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer, whereby the facing is adhered to the batt by the attachment of the bonding layer to the fibers in the batt due to the softening of the bonding layer.

2. The insulation product (60) of claim 1 in which the barrier layer (70) is vapor barrier.

3. The insulation product (60) of claim 1 in which difference in softening temperatures for the barrier layer (70) and the bonding layer (72) is within the range of from about 50°F (10°C) to about 225°F (107°C).

4. The insulation product (60) of claim 1 in which the facing (64) is cuttable, does not soften at less than 110°F (43°C), and is not brittle at temperatures greater than about 30°F (-1°C).

5. The insulation product (60) of claim 1 in which the batt (62) has edges, and the facing (64) has extensions beyond the edges of the batt for tucking between the edge of the insulation product and a construction wall stud.

6. The insulation product (60) of claim 1 in which the facing (64) has a flexural rigidity less than 500 gm cm.

7. The insulation product (60) of claim 1 in which the facing (64) has an elastic modulus within the range of from about 25,000 to about 200,000 pounds per square inch (about .172 to about 1.38 GPa).

8. The insulation product (60) of claim 1 in which the barrier layer (70) is selected from the group of polyethylene, polypropylene, polyester and polystyrene.

9. The insulation product (60) of claim 1 in which the insulation product has a friction enhancing portion on the sides of the insulation product to aid friction fit of the insulation product in an insulation cavity (16, 18, 20).

10. The insulation product (60) of claim 1 in which the bonding layer (72) is low density polyethylene.

11. An insulation product (60) comprising an elongated batt (62) of fibrous insulation material, and a facing (78) adhered to a major surface of the batt, wherein the facing is a coextruded polymer film of, carrier (84) and bonding layers (82) and at least one barrier layer (80), with the bonding layer having a softening point lower than the softening point of the barrier layer, and with the carrier layer being positioned between the barrier and bonding layers, wherein the facing has been heated to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer, whereby the facing is adhered to the batt by the attachment of the bonding layer to the fibers in the batt due to the softening of the bonding layer.

12. The insulation product (60) of claim 11 in which the carrier layer (84) provides an insulative barrier between the barrier layer (80) and the bonding layer (82) during the coextrusion of the polymer film sufficient to improve the permissible difference in softening temperatures between the barrier layer and the bonding layer by at least 30°F (-1°C).

13. The insulation product (60) of claim 11 in which the carrier layer (84) is a linear low density polyethylene or a high density polyethylene.

14. The insulation product (60) of claim 11 in which difference in softening temperatures for the barrier layer (80) and the bonding layer (82) is within the range of from about 50°F (10°C) to about 225°F (107°C).

15. A method of making an insulation product (60) comprising:

positioning a facing (64) in contact with a major face of an elongated batt (62) of fibrous insulation material, wherein the facing is a coextruded polymer film of a bonding layer (72) and at least one barrier layer (70), with the bonding layer being one or more materials of the group consisting of ethylene N-butyl acrylate, ethylene methyl acrylate, ethylene ethyl acrylate, low density polyethylene and ethylene vinyl acetate, and with the bonding layer having a softening point lower than the softening point of the barrier layer; and

heating the facing to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer, while maintaining the facing in contact with the batt to soften the bonding layer to an extent sufficient to attach the

bonding layer to the fibers in the batt and thereby adhere the facing to the batt.

16. The insulation product (60) of claim 15 in which the barrier layer (70) is a film and the bonding layer (72) is a plurality of discrete bonding portions.

17. The insulation product (60) of claim 15 in which the bonding layer (72) is one or more materials of the group consisting of ethylene N-butyl acrylate, ethylene methyl acrylate, low density polyethylene and ethylene ethyl acrylate.

18. A method for installing an insulation product (60) comprising:

providing an insulation product comprising an elongated batt (62) of fibrous insulation material, and a facing (64) adhered to a major surface of the batt, wherein the facing is a coextruded polymer film of barrier and bonding layers, with the bonding layer having a softening point lower than the softening point of the barrier layer (70), and wherein the facing has been heated to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer, whereby the facing is adhered to the batt by the attachment of the bonding layer to the fibers in the batt due to the softening of the bonding layer, and wherein the facing has no flanges; and

installing the insulation product in an insulation cavity (16, 18, 20) by pressing the insulation product into place between opposed structural members.

19. The method of claim 18 in which the opposed structural members are wall studs (14).

20. The method of claim 18 in which the facing (64) has extension flaps (92).

21. A method of attaching a facing (64) to a mineral fiber batt (62), the method comprising:

providing said batt;

providing said facing;

positioning said facing to be in contact with said batt; and

ultrasonically energizing said facing sufficient to melt a portion of said facing onto fibers of said batt.

22. The method of claim 21, further comprising:

compressing said facing (64) against said batt (62) before ultrasonically energizing said facing.

23. The method of claim 22, further comprising:

compressing said facing (64) against said batt (62) after ultrasonically energizing said facing.

24. The method of claim 21, wherein said facing (1200) is a coextruded polymer film having at least a first layer (1204) and a second layer (1206) on said first layer, said first layer being a bonding layer, said first layer being resonant at a first frequency of ultrasonic radiation, said second layer not being resonant at said first frequency.

25. The method of claim 24, wherein said bonding layer (1204) is one of low density polyethylene, ethylene N-butyl acrylate, ethylene methyl acrylate, ethylene ethyl acrylate, low density polyethylene and ethylene vinyl acetate.

26. The method of claim 24, wherein said second layer (1206) is a carrier layer (1302).

27. The method of claim 26, wherein said carrier layer (1302) is also a vapor barrier layer.

28. The method of claim 27, wherein said carrier layer (1302) is one of polyethylene, polypropylene, polyester and polystyrene.

29. The method of claim 26, wherein said facing (1200) includes a third layer, said third layer exhibiting greater printability than said carrier layer (1302), said carrier layer being formed between said first layer (1204) and said third layer (1206).

30. The method of claim 21, wherein said facing (64) is 0.5 - 1.0 mil (12.5 – 25 microns) thick.

31. The method of claim 30, wherein said facing (64) is 0.5 mil (12.5 microns) thick.

32. An apparatus for attaching a facing (64) to a mineral fiber batt (62), the apparatus comprising:

an arrangement to provide said batt;

a facing source;

a roller (114) arranged to place said facing into contact with said batt;

an ultrasonic emitter (120), located after a point at which said facing has been brought into contact with said batt, to irradiate said facing sufficiently to melt a portion of said facing onto fibers of said batt.

33. A method of ultrasonically brazing two pieces of plastic together, the method comprising:

providing a first piece of plastic (1102) and a second piece (1104) of thermoplastic;

arranging a plastic solder layer (1106) on a surface of said first piece that is to be joined to said second piece of plastic;

positioning said second piece to contact said plastic solder layer; and

ultrasonically energizing said facing sufficiently to weld a first portion of said plastic solder layer to said first piece and to weld a second portion of said plastic solder layer to said second piece.

34. The method of claim 33, wherein said plastic solder layer (1106) is a coextruded polymer.

35. The method of claim 34, wherein said coextruded polymer film has at least a first layer (1204) and a second layer (1206) on said first layer, said first layer being of the same material as said first piece (1102) and said second layer being of the same material as said second piece (1104).

36. The method of claim 35, wherein said material of said first piece (1102) and said first layer (1204) is different than said material of said second piece (1104) and said second layer (1206).

37. The method of claim 34, wherein said coextruded polymer film includes a third layer (1300) between said first and second layers (1204, 1206), said first layer being resonant at a first frequency of ultrasonic radiation, said second layer being resonant at a second frequency of ultrasonic radiation, said third layer not being resonant at said first or second frequencies.

38. The method of claim 34, wherein said coextruded polymer film includes at least one of polyethylene, ethylene N-butyl acrylate, ethylene methyl acrylate, ethylene ethyl acrylate, ethylene vinyl acetate, polypropylene, polyester and polystyrene.

39. The method of claim 34, wherein said coextruded polymer film is 0.5 - 1.0 mil (12.5 – 25 microns) thick.

40. The method of claim 39, wherein said coextruded polymer film is 0.5 mil (12.5 microns) thick.

41. The method of claim 33, wherein said material of said first piece (1102), said plastic solder layer (1106) and said second piece (1104) are of the same material.

42. The method of claim 33, wherein at least one of said first plastic piece

(1102) and said second plastic piece (1104) is a composite material.

43. The method of claim 20, further comprising tucking said extension flaps (92) between edges of said insulation product (60) and sides of said structural members (14).

44. A conjoined plastic assembly comprising:

a first piece of plastic (1102);

a second piece of plastic (1104); and

a copolymer solder layer (1106) joining the first plastic piece to the second plastic piece.

45. The conjoined plastic assembly of claim 44, wherein said first plastic piece (1102) is of a different type of plastic than said second plastic piece (1104).

46. The conjoined plastic assembly of claim 44, wherein said copolymer solder layer has at least three layers, a first layer (1204) for adhering to said first plastic piece (1102), a third layer (1300) for adhering to said second plastic piece (1104) and a carrier layer (1302) between said first layer and said second layer (1206).

47. The method of claim 26, wherein said second layer (1206) is a barrier layer.

48. A method for installing an insulation product (60) comprising:

providing insulation products comprising elongated batts (62) of fibrous insulation material;

installing the insulation products in insulation cavities (16, 18, 20) by pressing the insulation products into place between opposed structural members (14), respectively; and

attaching a separate continuous vapor barrier across the installed insulation products and structural members, said separate continuous vapor barrier being a copolymer film.

49. An insulated studded wall construction comprising:

a studded wall (14) having a plurality of cavities (16, 18, 20) between opposed structural members;

insulation products (60) installed in said insulation, respectively; and

a separate continuous vapor barrier attached across said insulation products and said structural members, said separate continuous vapor barrier being a copolymer film.

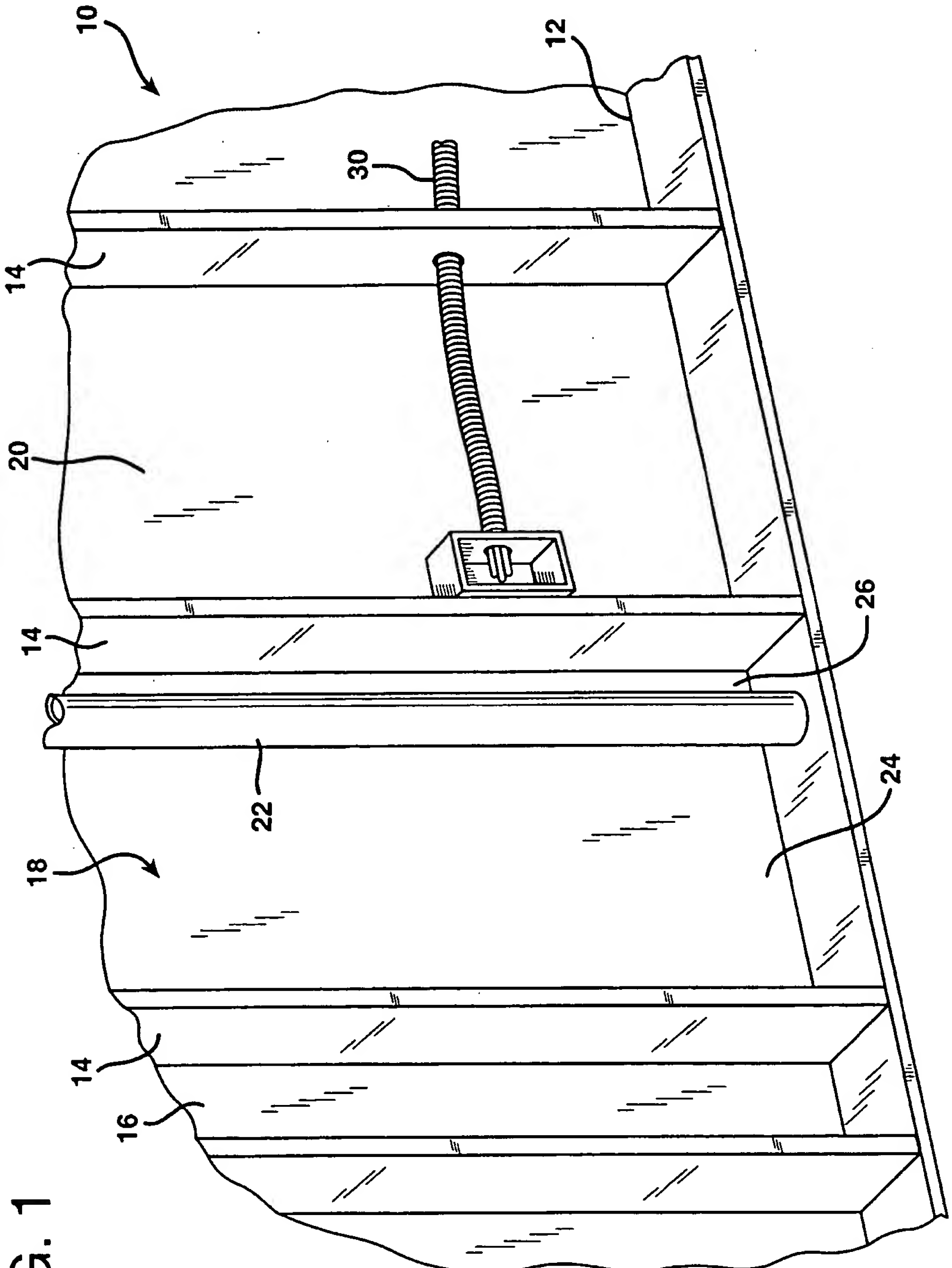


FIG. 1

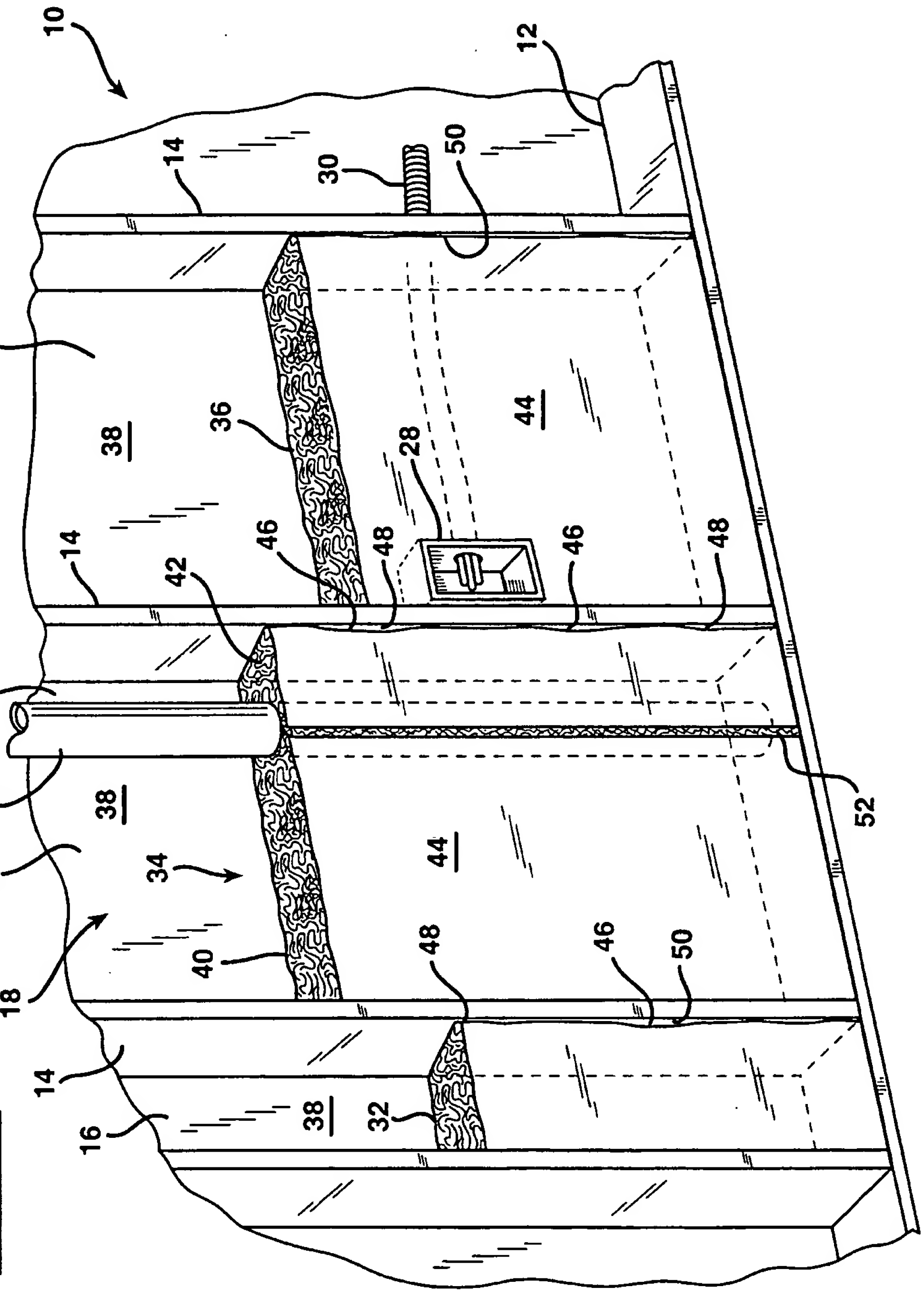
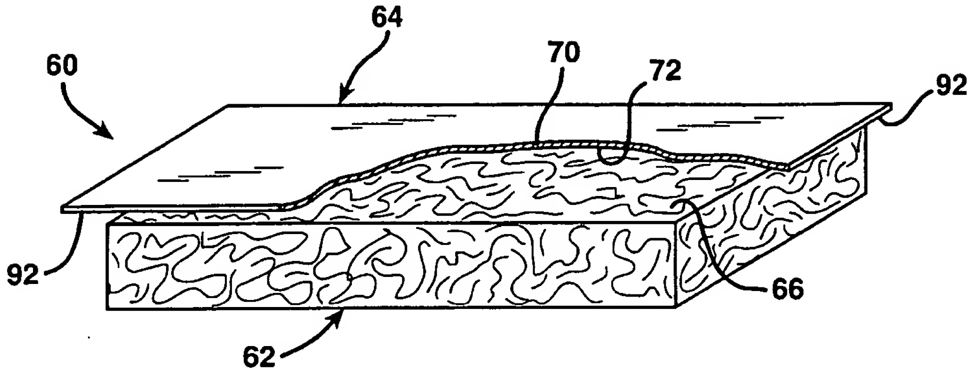


FIG. 2 PRIOR ART

FIG. 3



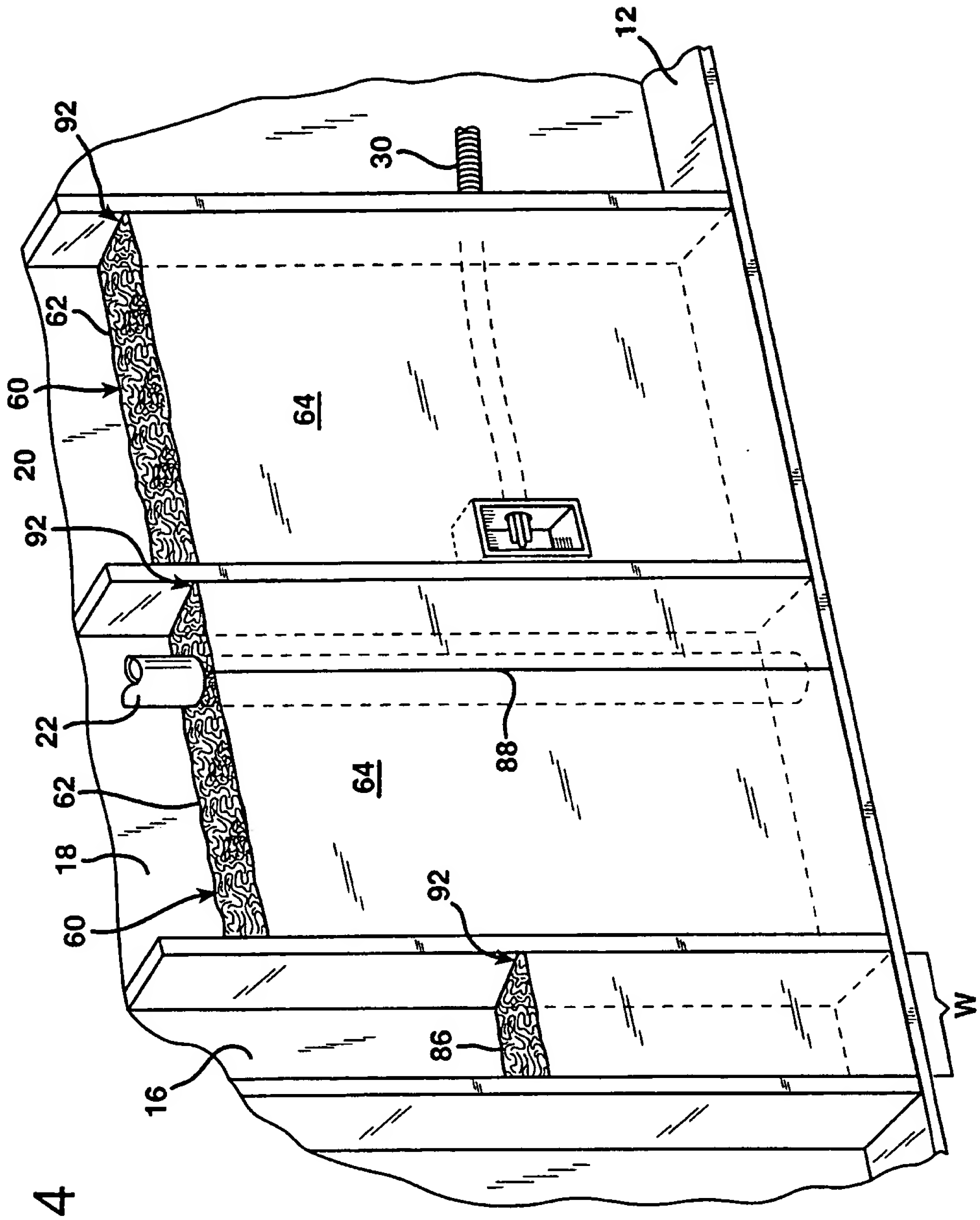


FIG. 4

FIG. 5

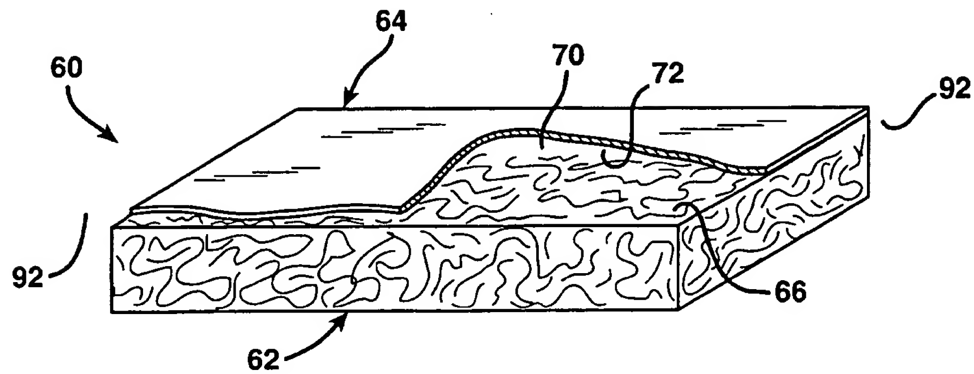
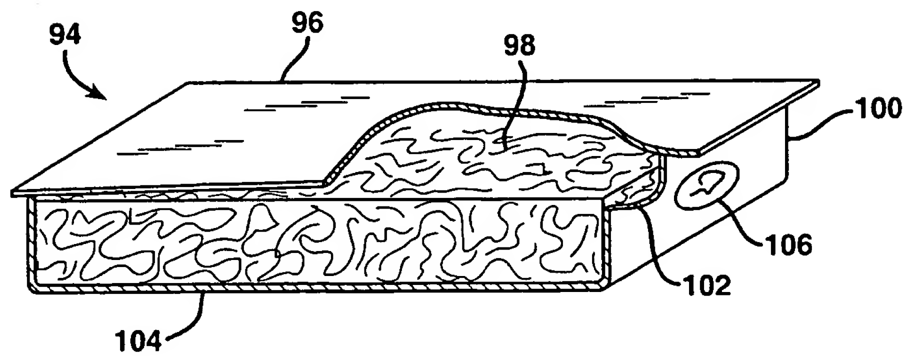


FIG. 6



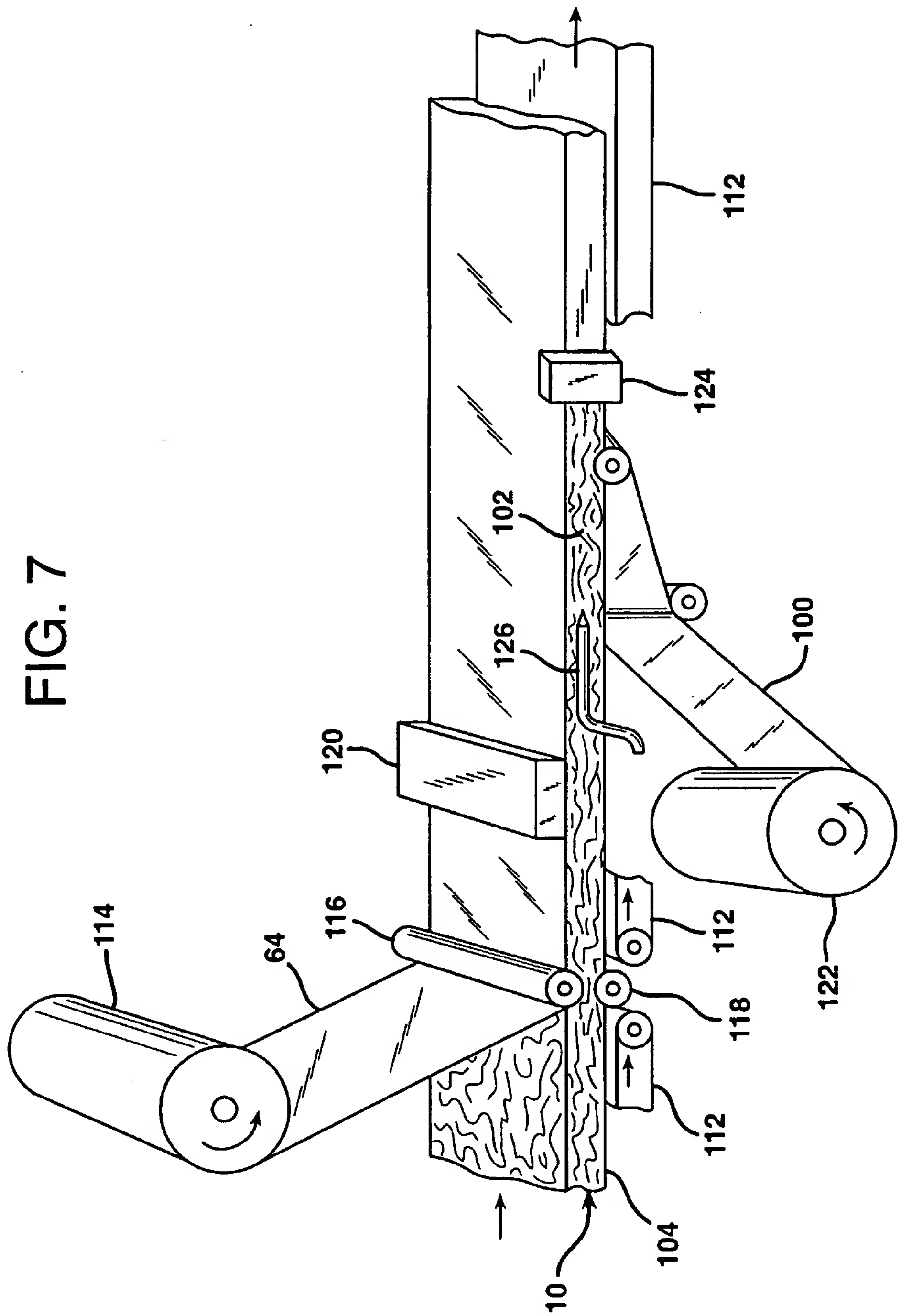


FIG. 7

FIG. 9

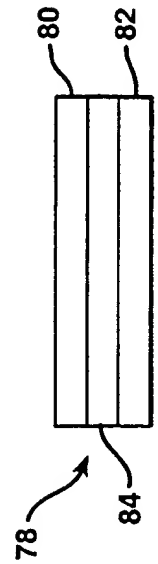
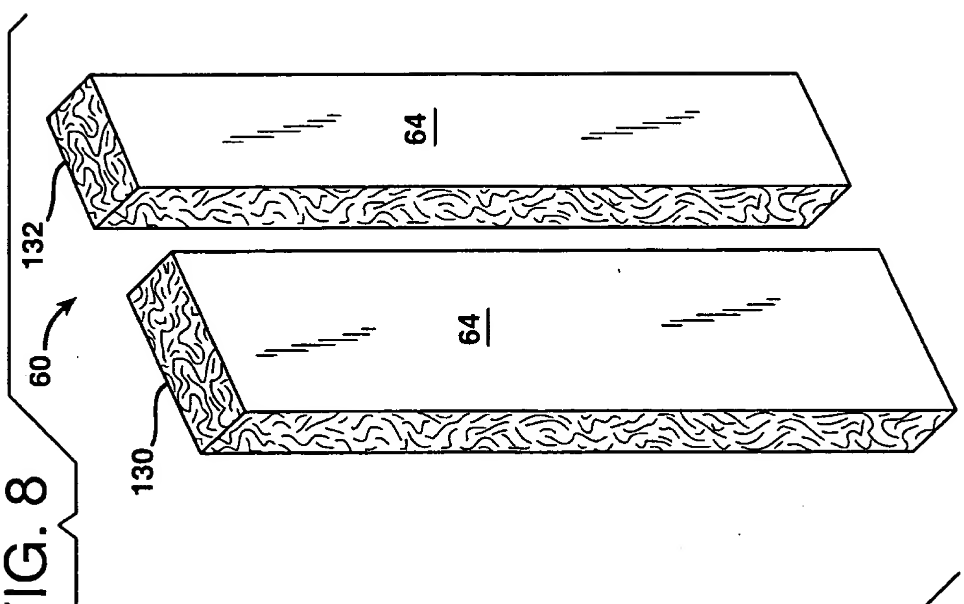


FIG. 8



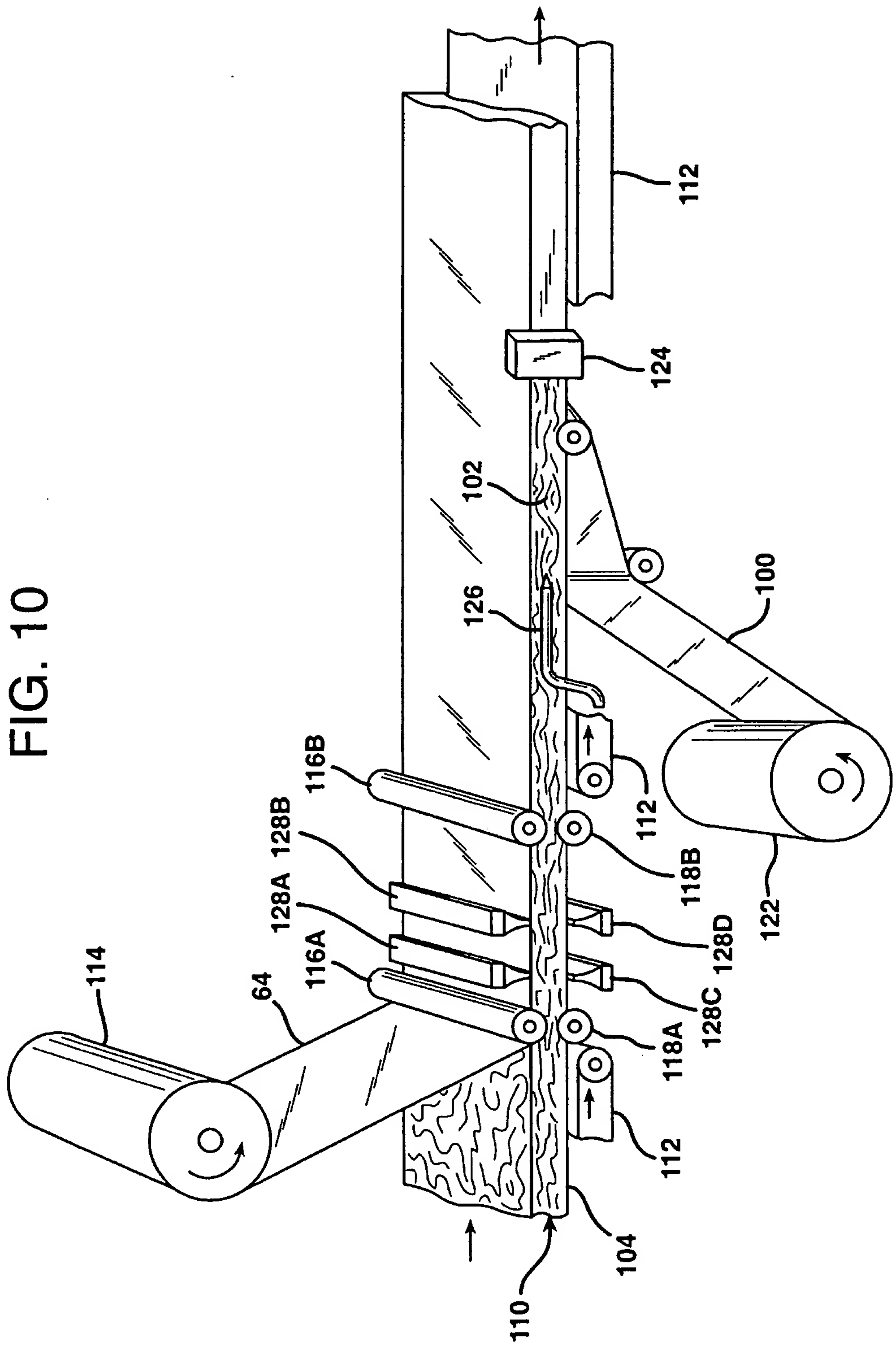

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FIG. 10

FIG. 11

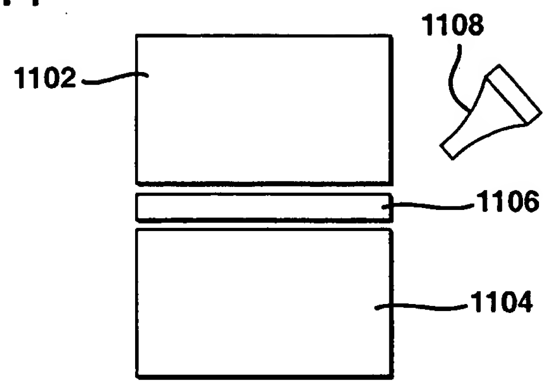


FIG. 12

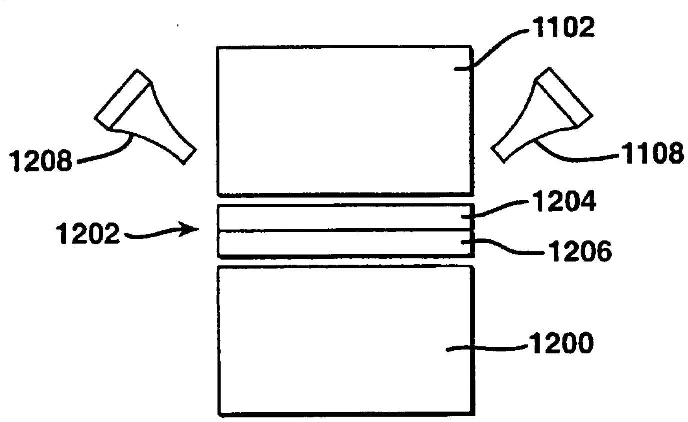
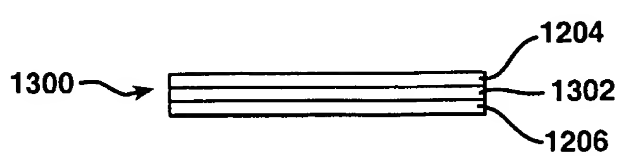
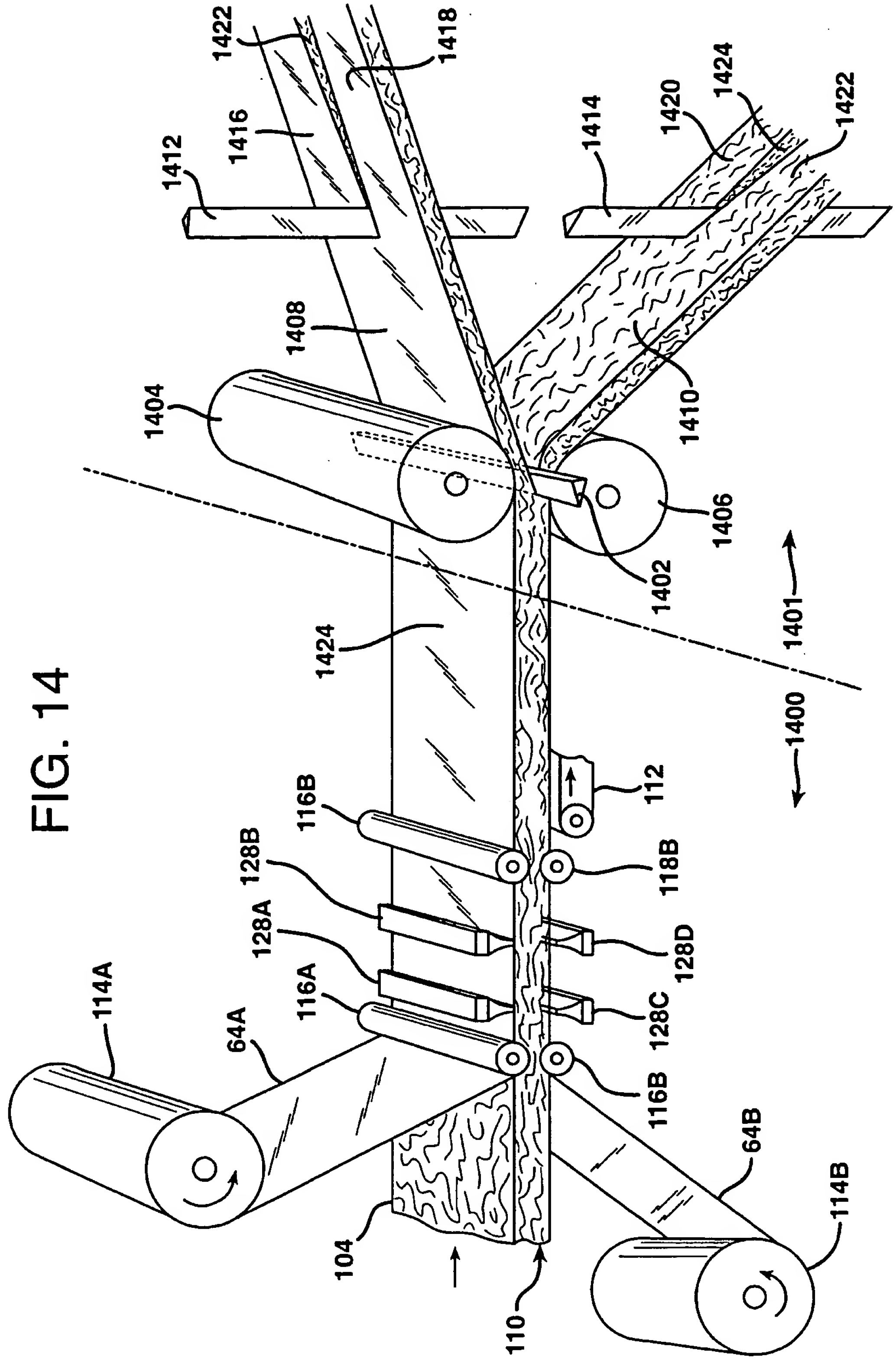


FIG. 13

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116B
118B
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128D
128A
128C
116A
116B
114A
64A
64B
114B
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FIG. 14

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 February 2001 (08.02.2001)

PCT

(10) International Publication Number
WO 01/09445 A3

(51) International Patent Classification[7]: E04B 1/76, E04D 13/16, B29C 65/08, B32B 31/00

(21) International Application Number: PCT/US00/18427

(22) International Filing Date: 5 July 2000 (05.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/354,749 29 July 1999 (29.07.1999) US

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(72) Inventors; and
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(74) Agents: **BARNS, Stephen, W.** et al.; Owens Corning Science & Technology Center, 2790 Columbus Road, Building 54-1, Granville, OH 43023-1200 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

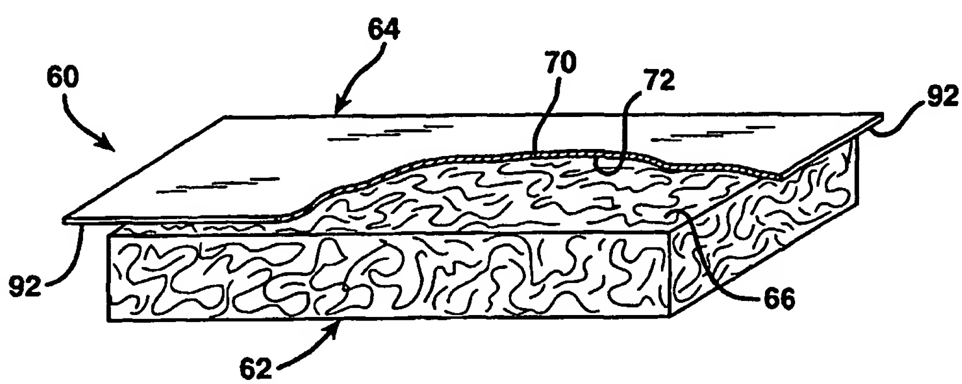
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

(88) Date of publication of the international search report: 26 April 2001

[Continued on next page]

(54) Title: TECHNOLOGY FOR ATTACHING FACING SYSTEM TO INSULATION PRODUCT



(57) Abstract: An insulation product (60) includes an elongated batt (62) of fibrous insulation material, and a facing (64) adhered to a major surface of the batt. The facing is a coextruded polymer film of barrier (70) and bonding (72) (and preferably carrier) layers, with the bonding layer having a softening point lower than the softening point of the barrier layer. The bonding layer can include one or more of ethylene N-butyl acrylate, ethylene methyl acrylate, low density polyethylene and ethylene ethyl acrylate. When the facing has been heated to a temperature above the softening point of the bonding layer, but below the softening point of the barrier layer, the facing is adhered to the batt by the attachment of the bonding layer to the fibers in the batt due to the softening of the bonding layer. The heating can be either conduction heating or ultrasonic heating. Also disclosed is a technology for ultrasonically brazing two pieces of plastic together.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/18427

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E04B1/76 E04D13/16 B29C65/08 B32B31/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E04B E04D B29C B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 99 63175 A (OWENS CORNING FIBERGLASS CORP ;GRANT LARRY J (US); PATEL BHARAT D) 9 December 1999 (1999-12-09) the whole document	1-32,43
X	US 5 733 624 A (SYME ROBERT W ET AL) 31 March 1998 (1998-03-31) cited in the application the whole document	1-10,15, 18-20
Y		17
A		11

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 January 2001	22. 01. 01

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Fageot, P

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Intern. nal Application No
PCT/US 00/18427

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	column 2, line 7 - line 18 column 5, line 15 - line 20; figure 4 -----	39

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International application No.
PCT/US 00/18427

INTERNATIONAL SEARCH REPORT

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [ ] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. [X] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[X] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-20

   when bounding a plastic facing to a batt of fibrous insulation material, allowing to use a barrier layer and a bonding layer with respective softening points close from each other and reducing the amount of bonding material.

2. Claims: 21-47

   to provide energy to a facing so that it can melt and bond to a mineral fiber batt and to brase two pieces of plastic together.

3. Claims: 48,49

   vapour barrier for an insulated wall

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 00/18427

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Inter. nal Application No
PCT/US 00/18427

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